International Journal of Agricultural Science
and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 5, Issue 3, Jun 2015, 349-354

EVALUATION OF NEW MOLECULES OF FUNGICIDES AGAINST LEAF SPOT (*ALTERNARIABRASSICICOLA* (SCHW.) WILTSHIRE) OF CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA* L.)

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ABSTRACT

The efficacy of new molecules of fungicides was evaluated against *A. brassicicola*of cabbage under *in vitro* andField *conditions* during kharif and summer 2013-14. All of fungicides were completely inhibited fungus growth at 1000 ppm concentration, also have been effective to inhibit the growth of *A. brassicicola* at 100, 250 and 500 ppm concentrations. Tebuconazole, Mancozeb and Propiconazole restricted 100 per cent inhibition of fungal growth of *A. brassicicola* at 100, 250, 500 and 1000 ppm. In field trials, Tebuconazole, Trifloxystrobin +Tebuconazole and Propiconazole reduced disease severity compared to untreated check in both seasons tested. The good quality of cabbage heads with higher yields were obtained in Tebuconazole, Trifloxystrobin + Tebuconazole, Mancozeb and Propiconazole sprayed plots, compared to untreated check.

KEYWORDS: Cabbage, Fungicides, *Alternariabrassicicola*, Management

INTRODUCTION

The cabbage (*Brassica oleracea* var. *capitata* L.) belongs to family Brassicaceae which comprises of 3500 species from 350 genera, but the most economically important crop species are in a single genus. Cabbage yield reduced worldwide due to infection of leaf spot (*Alternariabrassicicola*) and black rot (*Xanthomonascampestris*pv. *campestris*) (King, 1994). The first symptom of the disease appears with minute yellow specks on the oldest leaves and stems. Thespots are darkened and enlarged into circular, tan to dark brown spots. Alternating light and dark concentric rings give the spots the appearance of a target; a yellow halo may surround the lesion. *Alternaria brassicicola* and *A. brassicae* are caused dark leaf spots of cultivated and wild crucifers (Smith *et al*., 1988). Other sources of inoculum include infested debris in soil, infected weeds, and nearby infected cruciferous crops. Alternaria black spot disease is one of the main causes of low yields in brassicas. *Alternaria* species can be serious at higher tropical elevation (Tewari, 1991). One of the most effective and method for disease control is the use of fungicides. There are several new molecules of fungicides which are commercially available were evaluated against *Alternaria*leaf spot of cabbage in laboratory and field conditions.

MATERIALS AND METHODS

The efficacies of thirteen fungicides were evaluated against *A. brassicicola*at 100, 250, 500 and 1000 ppm concentrations on potato dextrose agar medium using poisoned food technique. The fungicide suspension was made by adding required quantity of fungicides to the molten potato dextrose agar medium to obtain the desired concentration on the basis of active ingredient present in the chemical. 15ml of poisoned medium was poured in each sterilized petriplates and suitable checks were maintained without addition of fungicides. Five mm of ten days old fungal disc was placed in the

center of the poisoned medium and the plates were incubated at 27±1˚C for seven days. Three replications were maintained for each treatment. The diameter of the colony was measured and the per cent inhibition was calculated by using the formula as suggested by Vincent (1947).

The field experiments were conducted to for the management of Alternarialeaf spot in cabbage (*Alternariabrassicicola)* during Kharif and Summer 2013-2014 at G.K.V.K., Bangalore. The experiments were laid out in Randomized Complete Block Design with a plot size of 4 x 5m with eleven fungicides (Table 2) with three replications were maintained by planting cabbage variety Unnathi. The 15 days old cabbage seedlings were artificially inoculated with the pathogen ($2x10^4$spores/ml) to get the infection on leaf. The fungicides were sprayed at recommended dosage after getting infection of *Alternaria*on foliage with high volume sprayer fitted with hollow cone nozzle. The spray was given after 30days and 45 days of the crop after infection. The observations on per cent severity of *Alternaria*leaf spot was recorded before fungicide application, 5^{th} and 10^{th} day of first application of fungicide spray and 5^{th} the 10^{th} day after second application of fungicides. The observations on per cent severity and cabbage head infection were recorded on randomly selected 5 plants in each replicated plot. At the end of the experiment, the cabbage yield was recorded in each treated plots and yield was expressed as kg/plot and then converted into ton/ha.

RESULTS AND DISCUSSIONS

Thirteen fungicides were evaluated at different concentrations under *in vitro* conditions. Among, fungicides Tebuconazole, Mancozeb and Propiconazolecompletely inhibited fungal growth at all the concentrations tested (100, 250, 500 and 1000ppm). Pyraclostrobin +Hydrocarbons recorded highest inhibition of the fungus growth (81.97%), followed by Hexaconazole + Zineb(78.99%), Difenoconazole(75.89%), Trifloxystrobin + Tebuconazole(70.84%), Hexaconazole (60.84), Metalaxyl + Mancozeb (59.70), Trifloxystrobin (50.86%), Copper oxy chloride (40.87%) at 100ppm concentration. Least inhibition of the fungus growth was observed at 100 ppm of Carbendazim(26.17%) and Chlorothalonil(26.75%). At 250 ppm, Pyraclostrobin +Hydrocarbons, Hexaconazoleand Hexaconazole + Zinebwere found effective in inhibiting the fungal growth (100%) followed byTrifloxystrobin+Tebuconazole (81.51%), Difenoconazole (80.71%), Copper oxy chloride (71.07%), Chlorothalonil (69.69%), Trifloxystrobin (69.63%), Metalaxyl + Mancozeb (65.67%) and Carbendazim (50.63%) respectively. At 500ppm, Difenoconazole, Chlorothalonil, Hexaconazole + Zineb, Pyraclostrobin +Hydrocarbons, Metalaxyl + Mancozebshowed 100 per cent inhibition against *Alternaria*leaf spot pathogen. Least growth inhibition was observed in Trifloxystrobin(77.73%) and Carbendazim(78.07%) (Table 1). Mancozeb, Tebuconazole and Propiconazole were effective at all concentrations tested against *A. brasicicola*. Considering the economic importance and serious nature of the disease and in the absence of suitable resistance genotype of the crop, chemical method of control is dependable method to control disease. Under *in vitro* conditions the efficiency of fungicides can be easily evaluated in short period with less cost by adopting poison food technique. In the present investigation, the efficacy of thirteen fungicides was tested against *Alternariabrassicicola*at four concentrations for radial growth inhibition on the potato dextrose agar medium. The present study revealed that, at higher concentrations, Trifloxystrobin+Tebuconazole, Tebuconazole and Propiconazole were effective against*A. brasicicola.* Least inhibition was observed in Carbendazim, Chlorothalonil and Copper oxy chloride fungicides. The results findings are similar to those of Arunkumar (2006), who reported thatsystemic fungicides evaluated against *A. brassicicola*propiconazole (84.57%) gave maximum inhibition of the mycelial growth of pathogen. Further, these fungicides were tested under field conditions to know the efficacy against *Alternaria*leaf spot disease. Surviliene and Dambraukiene (2006) reported to the impact of

different active ingredients boscalid, Pyraclostrobin (Signum 334 WG) and Tebuconazole (Folicur 250 EW) were distinguished for their inhibitory activity on the growth of *Alternaria* spp. colonies throughout and persisted 71 per cent and 62 per cent after 21 days respectively

Field trials were conducted during Kharif, 2013-14. The disease severity of *Alternaria*leaf spots on cabbage leaf and head damage was recorded before and after spray of the fungicides. The disease severity of *Alternaria*leaf spot were reduced in cabbage treated with Tebuconazole (4.62%),Trifloxystrobin +Tebuconazole (6.01%) and Propiconazole (9.45%), which were found best among the other fungicides. Mancozeb (11.4%) Difenoconazole (10.49%), Pyraclostrobin+Hydrocarbons (10.08%) are the next best fungicides for management of *Alternaria* leaf spot of cabbage. In untreated check, the per cent severity of leaf spot recorded maximum of 61.63per cent. The cabbagehead yield was increased in the Tebuconazole (28.67ton/ha.) Trifloxystrobin + Tebuconazole (25.85 ton/ha.), Mancozeb(24.82)ton/ha and Propiconazole (23.50 ton/ha) sprayed plot with the highest yield. The yield was drastically reduced in untreated control plot due to severe infection of leaf and head rot infection, the lowest yield obtained in untreated check was15.20 (ton/ha) and also lost quality of cabbage head due to severe infection of cabbage head (Table 2). Field trials conducted during summer 2013-14 showed that the disease severity of *Alternaria*leaf spots on leaf andhead was reduced in cabbage treated with Tebuconazole (1.72%), Trifloxystrobin+Tebuconazole (2.68%), Mancozeb (2.90%) and Propiconazole (4.87%) which reduced the severity of leaf spot and obtained good quality cabbage heads in these treatments. In untreated plots, the severity of disease was significantly increased by 58.59 per cent and also wasfound severely infected with leaf and head rot in this treatment. The yield increased in the Tebuconazole (27.36 ton/ha), Trifloxystrobin+Tebuconazole (26.94 ton/ha), Mancozeb (26.79 ton/ha) and Propiconazole (26.46 ton/ha) treated plots with good quality of cabbage heads. In untreated check, loweryield was recorded 18.72 ton/ha. (Table 3). Amaresh (2000) observed that Propiconazole was effective against *A. helianthi.* Mondal*et al*. (1989) found that Mancozeb was effective for the control of *Alternaria*blight in radish. Pandey*et al*. (2000) conducted a field experiment to control brinjal leaf spot caused by *Alternariaalternata*, and reported that Mancozeb (0.2%) was superior to other tested fungicides. It reduced disease severity by 65.26 per cent over control. Similar to reported by Hosagoudar *et. al*., 2014, The field experiments were conducted to control Alternaria leaf spot disease in Bt cotton by Propiconazole recorded lowest Alternaria leaf spot per cent disease index (3.78 PDI) and significantly increased yield of 2894.5 kg per ha. Archana and Jamadar (2014) also reported that Propiconazole sprayedplot reduced disease incidence (PDI-4.37%) followed by thiophanate methyl and hexaconazole recording 11.70 and 14.47 per cent disease index respectively. The fungicides, Tebuconazole, Trifloxystrobin +Tebuconazole, Mancozeb and Propiconazole were found to be effective in both *in vitro* conditions and field during kharif and summer season 2013-14. Even the disease pressure was low during summer, hence, the plot was inoculated with pathogen and inoculum level was build up more in the field before fungicide application. Propiconazole reduced disease severity in field but the plants showed stunted growth due to phytotoxicity. The good quality of cabbage heads with higher yields were obtained during both the seasons in the fungicides Tebuconazole,Trifloxystrobin+Tebuconazole, Mancozeb and Propiconazolesprayed plots, compared to untreated check.

CONCLUSIONS

The new molecules of fungicides were evaluated in in vitro and field conditions in severely infected plots and found that the fungicides, Tebuconazole, Trifloxystrobin +Tebuconazole, Mancozeb and Propiconazole were reduced Alternaria leaf spot disease on cabbage in both the seasons and also obtained very good quality cabbage heads in these

fungicides sprayed plots.

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APPENDICES

Table 1: *In Vitro* Evaluation of Fungicides against *A. brassicicola* on Cabbage

Sl. No.	Common Name	Per Cent Inhibition Over Control			
		100 ppm	250 ppm	500 ppm	1000ppm
1.	Carbendazim	26.17 (35.13)	50.63 (44,02)	78.07 (62.19)	100.00 (90.0)
2.	Chlorothalonil	26.75 (46.81)	69.69 (56.59)	100.00 (90.0)	100.00 (90.0)
3.	Copper oxy chloride	40.87 (40.92)	71.07 (57.46)	81.17 (64.28)	100.00 (90.0)

4.	Difenoconazole	75.89 (24.72)	80.71 (64.54)	100.00 (90.0)	100.00 (90.0)
5.	Metalaxyl + Mancozeb	59.70 (32.72)	65.67 (54.13)	100.00 (90.0)	100.00 (90.0)
6.	Pyraclostrobin + Hydrocarbons	81.97 (21.20)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
7.	Trifloxystrobin+Tebuconazole	70.84 (58.42)	81.51 (63.95)	83.35 (66.11)	100.00 (90.0)
8.	Trifloxystrobin	50.86 (36.66)	69.23 (56.97)	77.73 (61.84)	100.00 (90.0)
9.	Hexaconazole + Zineb	78.99 (22.95)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
10.	Hexaconazole	60.84 (50.76)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
11.	Mancozeb	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
12.	Propiconazole	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
13.	Tebuconazole	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)	100.00 (90.0)
Mean		**69.50**	**84.89**	**94.31**	**100.00**
CD @0.1%		**9.57**	**2.44**	**1.73**	**0.00**
SEm ±		**3.27**	**0.61**	**0.43**	**0.00**
CV%		**11.96**	**1.48**	**0.92**	**0.00**

*The values in the parenthesis are arc sign transformed and the growth in untreated check was 70mm

Table 2: Effect of Fungicides against Leaf Spot (*Alternariabrassicicola*) of Cabbage(Ist Season Kharif2013-2014)

Sl. No.	Treatments	Dosage (%)	Per cent Severity of the Disease					Yield (Kg/plot)	Yield (ton/ha.)
			Before Application (30DAT)*	IstApplication		IInd Application			
				5 DAA*	10DAA	5DAA	10DAA		
T1	Carbendazim	0.1	23.17 (28.77)**	23.98 (29.32)	26.48 (30.97)	28.90 (32.54)	30.65 (33.57)	42.27 (40.53)	21.13
T2	Chlorothalonil	0.2	21.44 (27.58)	20.07 (26.61)	7.24 (24.53)	15.88 (23.48)	14.00 (21.96)	42.77 (40.83)	22.80
T3	Copper oxy chloride	0.2	25.33 (30.22)	17.84 (24.93)	15.37 (23.08)	15.25 (22.99)	11.85 (20.08)	45.60 (42.47)	22.75
T4	Difenoconazole	0.05	23.68 (29.11)	17.01 24.34)	13.99 (21.953)	14.77 (22.60)	10.49 (18.89)	46.00 (42.70)	23.00
T5	Pyraclostrobin + Hydrocarbons	0.1	25.57 (30.38)	16.58 (23.99)	12.54 (20.73)	10.84 (19.21)	10.08 (18.50)	45.77 (42.57)	22.89
T6	Metalaxyl + Mancozeb	0.2	23.00 (28.66)	14.88 (22.66)	12.92 (21.05)	9.88 (18.31)	11.78 (20.06)	45.00 (42.13)	23.50
T7	Propiconazole	0.1	22.81 (28.47)	15.37 (23.08)	11.80 (20.09)	9.26 (17.70)	9.45 (17.88)	46.95 (42.70)	23.48
T8	Hexaconazole + Zineb	0.1	26.44 (30.95)	14.39 (22.27)	11.28 (19.59)	10.41 (18.80)	8.69 (17.18)	45.26 (42.28)	24.50
T9	Mancozeb	0.2	22.80 (28.48)	14.17 (22.08)	11.51 (19.82)	8.77 (17.16)	11.40 (19.65)	49.63 (48.01)	24.82
T10	Trifloxystrobin + Tebuconazole	0.1	25.35 (30.17)	13.51 (21.52)	9.32 (17.76)	7.82 (16.19)	6.01 (14.13)	51.69 (45.97)	25.85
T11	Tebuconazole	0.1	25.76 (30.50)	11.54 (19.85)	7.78 (16.19)	6.30 (14.25)	4.62 (12.40)	57.34 (49.22)	28.67
T12	Control		24.88 (29.92)	33.02 (35.06)	39.47 (38.62)	47.10 (43.33)	61.63 (51.70)	30.40 (33.46)	15.20
Mean			**24.18**	**17.70**	**14.98**	**15.43**	**15.89**	**45.75**	**23.22**
SEm±			**0.80**	**0.77**	**0.50**	**0.84**	**0.89**	**0.57**	
CD @1%			**3.18**	**3.07**	**1.99**	**3.32**	**3.51**	**2.256**	
CV%			**4.73**	**5.45**	**3.82**	**6.55**	**6.94**	**2.3112**	

*DAA: Days AfterFungicide Applications

**The values in the parenthesis are arc sine transformed

Table 3: Effect of Fungicides against Leaf Spot (*Alternariabrassicicola*) of Cabbage(2nd Season Summer 2013-2014)

Sl. No.	Treatments	Dosage (%)	Per Cent Severity of the Disease					Yield (Kg/plot)	Yield (ton/ha.)
			Before Application (30DAT)*	Ist Application		IInd Application			
				5 DAA	10DAA	5DAA	10DAA		
T1	Carbendazim	0.1	11.66 (19.93)**	8.16 (16.59)	5.98 (14.14)	7.68 (16.09)	16.49 (23.96)	49.53 (44.97)	24.77
T2	Chlorothalonil	0.2	9.83 (18.25)	5.08 (12.96)	5.207 (13.19)	6.27 (14.43)	11.60 (19.89)	51.16 (45.66)	25.58
T3	Copper Oxychloride	0.2	10.66 (19.03)	4.30 (11.92)	4.253 (11.89)	6.52 (14.74)	10.02 (18.41)	50.69 (45.39)	25.35
T4	Difenaconazole	0.05	9.72 (18.10)	4.14 (11.74)	3.65 (10.98)	4.77 (12.60)	9.09 (17.53)	51.59 (45.91)	25.78
T5	Pyraclostrobin + Hydrocarbons	0.1	8.78 (17.22)	4.38 (12.08)	6.257 (14.48)	4.86 (12.65)	9.46 (17.91)	51.91 (45.58)	25.51
T6	Metalaxyl+ Mancozeb	0.2	11.53 (19.84)	7.19 (15.55)	4.22 (11.83)	9.93 (12.74)	8.49 (16.94)	52.63 (46.51)	26.31
T7	Propiconazole-	0.1	11.33 (18.60)	4.53 (12.28)	4.31 (11.97)	3.41 (10.40)	4.87 (12.73)	52.91 (46.67)	26.46
T8	Hexaconazole+ Zineb	0.1	11.38 (19.67)	5.32 (13.21)	3.98 (11.48)	1.78 (9.79)	3.82 (11.26)	52.86 (46.64)	26.43
T9	Macozeb	0.2	10.74 (19.11)	3.94 (11.45)	3.878 (11.20)	1.46 (7.66)	2.90 (9.80)	53.58 (47.05)	26.79
T10	Trifloxystrobin + Tebuconazole	0.1	11.15 (19.50)	5.92 (14.09)	3.69 (11.06)	1.33 (6.95)	2.68 (9.42)	53.88 (47.22)	26.94
T11	Tebuconazole	0.1	9.50 (18.89)	6.61 (14.90)	2.39 (8.88)	1.31 (6.67)	1.72 (7.47)	54.71 (47.71)	27.36
T12	Control	----	10.42 (18.83)	18.16 (25.30)	21.397 (27.55)	31.70 (34.26)	58.59 (49.95)	37.43 (37.72)	18.72
Mean			**10.56**	**6.49**	**5.77**	**6.75**	**11.64**	**51.07**	**25.51**
SEm ±			**0.74**	**0.46**	**0.39**	**0.63**	**0.53**	**0.26**	**0.89**
CD @1%			**2.96**	**1.85**	**1.54**	**2.52**	**2.09**	**0.86**	**3.54**
CV%			**6.81**	**5.62**	**5.07**	**8.26**	**5.11**	**0.83**	**5.07**

*DAA: Days after Fungicide Applications

**The values in the parenthesis are arc sine transformed